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Z-Pinch-Driven Inertial Confinement Fusion Target Physics Research at Sandia National Laboratories*

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Recent success in producing intense x-ray sources with fast z-pinch implosions on the Sandia Z accelerator (x-ray energies as high as 1.8 MJ and powers as high as 280 TW) has renewed interest in utilizing these x-rays to drive Inertial Confinement Fusion capsules. Several different hohlraum and target configurations have been proposed. In the Z-Pinch-Driven Hohlraum (ZPDH) concept, the fusion capsule is separated from the z-pinch implosions, and the radiation is coupled from the z-pinch hohlraums into a capsule hohlraum through a transparent Be-spoke configuration. Target design calculations indicate that fusion yields in excess of 500 MJ can be obtained in a configuration where the z-pinch implosions are driven by a peak current of 60 MA. Experiments on Z, where the peak current is 20 MA, have characterized the hohlraum energetic, the radiation coupling efficiency to the capsule hohlraum, and the radiation drive symmetry at a surrogate capsule in single-ended and double-ended drive configurations. We have demonstrated energetic and coupling efficiencies that are adequate to scale to high yield. In the Dynamic Hohlraum (DH) configuration, the fusion capsule is placed inside of the imploding z-pinch. At accelerator parameters relevant to achieving high yield, the imploding z-pinch mass has sufficient opacity to trap radiation. Placing the capsule internal to this dynamic hohlraum provides driver energy utilization efficiencies exceeding 20°/0. Calculations of this target concept using a peak current of 55 MA produce a capsule drive temperature exceeding 300 eV and 550 MJ of fusion yield. Initial experiments on Z to validate this concept have demonstrated a hohlraum temperature of 180+14 eV in a configuration that is suitable for driving capsules. Other target concepts, such as the Static-Walled Hohlraum, use the fundamental features of the ZPDH and DH in an attempt to optimize the tradeoffs between x-ray energy and power production, radiation drive symmetry, x-ray pulse shaping, and isolation of the fusion capsule from the z-pinch implosion. Recent advances in modeling and simulation provide us with the capability to perform detailed two-dimensional, integrated design calculations including Rayleigh-Taylor instabilities. Experiments are beginning to validate the physics issues in each of these target concepts. We will summarize recent high-yield design simulations along with recent experimental data supporting high-yield ICF driven by an intense z-pinch-driven x-ray source.

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